

7. (Currently amended) The method of claim + 239 wherein said final coefficient of friction is about 0.1 or less.

8. (Currently amended l) The method of claim + 239 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

9. (Currently amended) The method of claim + 239 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

10. (Original) The method of claim 2 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

11. (Original) The method of claim 2 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

12. (Original) The method of claim 3 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

13. (Original) The method of claim 3 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

14. (Original) The method of claim 4 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

15. (Original) The method of claim 4 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

16. (Currently amended) The method of claim + 239 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

B (

17. (Original) The method of claim 2 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

18. (Original) The method of claim 3 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

19. (Original) The method of claim 4 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

20. (Original) The method of claim 5 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

21. (Original) The method of claim 6 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

22. (Original) The method of claim 7 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

23. (Original) The method of claim 16 wherein said final hardness is about 15 GPa or more.

24. (Original) The method of claim 16 wherein said final hardness is about 20 GPa or more.

B (

25. (Original) The method of claim 16 wherein said final hardness is about 25 GPa or more.
26. (Original) The method of claim 17 wherein said final hardness is about 15 GPa or more.
27. (Original) The method of claim 17 wherein said final hardness is about 20 GPa or more.
28. (Original) The method of claim 17 wherein said final hardness is about 25 GPa or more.
29. (Original) The method of claim 18 wherein said final hardness is about 15 GPa or more.
30. (Original) The method of claim 18 wherein said final hardness is about 20 GPa or more.
31. (Original) The method of claim 18 wherein said final hardness is about 25 GPa or more.
32. (Original) The method of claim 19 wherein said final hardness is about 15 GPa or more.
33. (Original) The method of claim 19 wherein said final hardness is about 20 GPa or more.
34. (Original) The method of claim 19 wherein said final hardness is about 25 GPa or more.
35. (Original) The method of claim 20 wherein said final hardness is about 15 GPa or more.

31

36. (Original) The method of claim 20 wherein said final hardness is about 20 GPa or more.
37. (Original) The method of claim 20 wherein said final hardness is about 25 GPa or more.
38. (Original) The method of claim 21 wherein said final hardness is about 15 GPa or more.
39. (Original) The method of claim 21 wherein said final hardness is about 20 GPa or more.
40. (Original) The method of claim 21 wherein said final hardness is about 25 GPa or more.
41. (Original) The method of claim 22 wherein said final hardness is about 15 GPa or more.
42. (Original) The method of claim 22 wherein said final hardness is about 20 GPa or more.
43. (Original) The method of claim 22 wherein said final hardness is about 25 GPa or more.
44. (Original) The method of claim 2 wherein said final coefficient of friction is about 0.3 or less.
45. (Original) The method of claim 2 wherein said final coefficient of friction is about 0.2 or less.
46. (Original) The method of claim 2 wherein said final coefficient of friction is about 0.1 or less.

57

47. (Original) The method of claim 2 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

48. (Original) The method of claim 2 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

49. (Original) The method of claim 29 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

50. (Original) The method of claim 29 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

51. (Original) The method of claim 30 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

52. (Original) The method of claim 30 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

53. (Original) The method of claim 31 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

54. (Original) The method of claim 31 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

55. (Original) The method of claim 44 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

56. (Original) The method of claim 45 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

61

57. (Original) The method of claim 46 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

58. (Original) The method of claim 55 wherein said final hardness is about 15 GPa or more.

59. (Original) The method of claim 55 wherein said final hardness is about 20 GPa or more.

60. (Original) The method of claim 55 wherein said final hardness is about 25 GPa or more.

61. (Original) The method of claim 56 wherein said final hardness is about 15 GPa or more.

62. (Original) The method of claim 56 wherein said final hardness is about 20 GPa or more.

63. (Original) The method of claim 56 wherein said final hardness is about 25 GPa or more.

64. (Original) The method of claim 57 wherein said final hardness is about 15 GPa or more.

65. (Original) The method of claim 57 wherein said final hardness is about 20 GPa or more.

66. (Original) The method of claim 57 wherein said final hardness is about 25 GPa or more.

67. (Original) The method of claim 3 wherein said final coefficient of friction is about 0.3 or less.

67

68. (Original) The method of claim 3 wherein said final coefficient of friction is about 0.2 or less.

69. (Original) The method of claim 3 wherein said final coefficient of friction is about 0.1 or less.

70. (Original) The method of claim 3 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

71. (Original) The method of claim 3 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

72. (Original) The method of claim 41 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

73. (Original) The method of claim 41 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

74. (Original) The method of claim 42 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

75. (Original) The method of claim 42 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

76. (Original) The method of claim 43 wherein said sufficient quantity comprises from about 10 atomic % to about 40 atomic % X in relation to chromium content.

77. (Original) The method of claim 43 wherein said sufficient quantity comprises about 25 atomic % X in relation to chromium content.

78. (Original) The method of claim 67 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

821

79. (Original) The method of claim 68 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

80. (Original) The method of claim 69 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

81. (Original) The method of claim 78 wherein said final hardness is about 15 GPa or more.

82. (Original) The method of claim 78 wherein said final hardness is about 20 GPa or more.

83. (Original) The method of claim 78 wherein said final hardness is about 25 GPa or more.

84. (Original) The method of claim 79 wherein said final hardness is about 15 GPa or more.

85. (Original) The method of claim 79 wherein said final hardness is about 20 GPa or more.

86. (Original) The method of claim 79 wherein said final hardness is about 25 GPa or more.

87. (Original) The method of claim 80 wherein said final hardness is about 15 GPa or more.

88. (Original) The method of claim 81 wherein said final hardness is about 20 GPa or more.

B7



89. (Original) The method of claim 81 wherein said final hardness is about 25 GPa or more.

90. (Canceled)

91. (Currently amended) The method of claim 90 240 wherein said final coefficient of friction of said surface is about 0.3 or less.

92. (Currently amended) The method of claim 90 240 wherein said final coefficient of friction of said surface is about 0.2 or less.

93. (Currently amended) The method of claim 90 240 wherein said final coefficient of friction of said surface is about 0.1 or less.

94. (Currently amended) The method of claim 90 240 wherein said additive is selected from the group consisting of carbon monoxide, carbon dioxide, formic acid, methyl alcohol, ethyl alcohol, and acetone.

95. (Currently amended) The method of claim 90 240 wherein said ~~sufficient quantity~~ lubricous outer surface comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

96. (Currently amended) The method of claim 90 240 wherein said ~~sufficient quantity~~ lubricous outer surface comprises about 25 atomic % substituent in relation to chromium content.

97. (Currently amended) The method of claim 91 wherein said ~~sufficient quantity~~ lubricous outer surface comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

98. (Currently amended) The method of claim 91 wherein said ~~sufficient quantity~~ lubricous outer surface comprises about 25 atomic % substituent in relation to chromium content.

631

99. (Currently amended) The method of claim 92 wherein said ~~sufficient quantity~~ lubricous outer surface comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

100. (Currently amended) The method of claim 92 wherein said ~~sufficient quantity~~ lubricous outer surface comprises about 25 atomic % substituent in relation to chromium content.

101. (Currently amended) The method of claim 93 wherein said ~~sufficient quantity~~ lubricous outer surface comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

102. (Currently amended) The method of claim 94 wherein said ~~sufficient quantity~~ lubricous outer surface comprises about 25 atomic % substituent in relation to chromium content.

103. (Currently amended) The method of claim 94 wherein said ~~sufficient quantity~~ lubricous outer surface comprises from about 10 atomic % to about 40 atomic % substituent in relation to chromium content.

104. (Currently amended) The method of claim ~~90~~ 240 wherein said ~~sufficient quantity~~ lubricous outer surface comprises about 25 atomic % substituent in relation to chromium content.

105. (Original) The method of claim ~~90~~ 240 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

106. (Original) The method of claim 91 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

B7 1

107. (Original) The method of claim 92 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

108. (Original) The method of claim 93 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

109. (Original) The method of claim 94 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

110. (Original) The method of claim 105 wherein said final hardness is about 15 GPa or more.

111. (Original) The method of claim 105 wherein said final hardness is about 20 GPa or more.

112. (Original) The method of claim 105 wherein said final hardness is about 25 GPa or more.

113. (Original) The method of claim 106 wherein said final hardness is about 15 GPa or more.

114. (Original) The method of claim 106 wherein said final hardness is about 20 GPa or more.

115. (Original) The method of claim 106 wherein said final hardness is about 25 GPa or more.

116. (Original) The method of claim 107 wherein said final hardness is about 15 GPa or more.

321

117. (Original) The method of claim 107 wherein said final hardness is about 20 GPa or more.

118. (Original) The method of claim 107 wherein said final hardness is about 25 GPa or more.

119. (Original) The method of claim 108 wherein said final hardness is about 15 GPa or more.

120. (Original) The method of claim 108 wherein said final hardness is about 20 GPa or more.

121. (Original) The method of claim 108 wherein said final hardness is about 25 GPa or more.

122. (Original) The method of claim 109 wherein said final hardness is about 15 GPa or more.

123. (Original) The method of claim 109 wherein said final hardness is about 20 GPa or more.

124. (Original) The method of claim 109 wherein said final hardness is about 25 GPa or more.

125. (Canceled)

126. (Currently amended) The method of claim ~~125~~ 241 wherein said additive is selected from the group consisting of carbon monoxide, carbon dioxide, formic acid, methyl alcohol, ethyl alcohol, and acetone.

127. (Currently amended) The method of claim ~~125~~ 241 wherein said additive is selected from the group consisting of carbon monoxide ions and carbon dioxide ions.

B/

128. (Currently amended) The method of claim ~~125~~ 241 wherein said additive is carbon monoxide ions.

129. (Currently amended) The method of claim ~~125~~ 241 wherein said final hardness is about 15 GPa or more.

130. (Currently amended) The method of claim ~~125~~ 241 wherein said final hardness is about 20 GPa or more.

131. (Currently amended) The method of claim ~~125~~ 241 wherein said final hardness is about 25 GPa or more.

132. (Original) The method of claim 126 wherein said final hardness is about 15 GPa or more.

133. (Original) The method of claim 126 wherein said final hardness is about 20 GPa or more.

134. (Original) The method of claim 126 wherein said final hardness is about 25 GPa or more.

135. (Original) The method of claim 127 wherein said final hardness is about 15 GPa or more.

136. (Original) The method of claim 127 wherein said final hardness is about 20 GPa or more.

137. (Original) The method of claim 127 wherein said final hardness is about 25 GPa or more.

138. (Original) The method of claim 128 wherein said final hardness is about 15 GPa or more.

B |

139. (Original) The method of claim 128 wherein said final hardness is about 20 GPa or more.

140. (Original) The method of claim 128 wherein said final hardness is about 25 GPa or more.

141. (Canceled)

142. (Currently amended) The method of claim ~~141~~ 242 wherein said final coefficient of friction of said surface is about 0.3 or less.

143. (Currently amended) The method of claim ~~141~~ 242 wherein said final coefficient of friction of said surface is about 0.2 or less.

144. (Currently amended) The method of claim ~~141~~ 242 wherein said final coefficient of friction of said surface is about 0.1 or less.

145. (Currently amended) The method of claim ~~141~~ 242 wherein said ~~sufficient quantity~~ surface comprises from about 10 atomic % to about 40 atomic % oxygen in relation to chromium content.

146. (Currently amended) The method of claim ~~141~~ 242 wherein said ~~sufficient quantity~~ surface comprises about 25 atomic % oxygen in relation to chromium content.

147. (Currently amended) The method of claim 142 wherein said ~~sufficient quantity~~ surface comprises from about 10 atomic % to about 40 atomic % oxygen in relation to chromium content.

148. (Currently amended) The method of claim 142 wherein said ~~sufficient quantity~~ surface comprises about 25 atomic % oxygen in relation to chromium content.

B1

149. (Currently amended) The method of claim 143 wherein said ~~sufficient quantity~~ surface comprises from about 10 atomic % to about 40 atomic % oxygen in relation to chromium content.

150. (Currently amended) The method of claim 143 wherein said ~~sufficient quantity~~ surface comprises about 25 atomic % oxygen in relation to chromium content.

151. (Currently amended) The method of claim 144 wherein said ~~sufficient quantity~~ surface comprises from about 10 atomic % to about 40 atomic % oxygen in relation to chromium content.

152. (Currently amended) The method of claim 144 wherein said ~~sufficient quantity~~ surface comprises about 25 atomic % oxygen in relation to chromium content.

153. (Currently amended) The method of claim ~~141~~ 242 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

154. (Original) The method of claim 142 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

155. (Original) The method of claim 143 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

156. (Original) The method of claim 144 wherein said surface comprises an initial hardness and said conditions are effective to produce a final hardness that is greater than said initial hardness.

B/

157. (Currently amended) The method of claim ~~141~~ 242 wherein said final hardness is about 15 GPa or more.

158. (Currently amended) The method of claim ~~141~~ 242 wherein said final hardness is about 20 GPa or more.

159. (Currently amended) The method of claim ~~141~~ 242 wherein said final hardness is about 25 GPa or more.

160. (Original) The method of claim 142 wherein said final hardness is about 15 GPa or more.

161. (Original) The method of claim 142 wherein said final hardness is about 20 GPa or more.

162. (Original) The method of claim 142 wherein said final hardness is about 25 GPa or more.

163. (Original) The method of claim 143 wherein said final hardness is about 15 GPa or more.

164. (Original) The method of claim 143 wherein said final hardness is about 20 GPa or more.

165. (Original) The method of claim 143 wherein said final hardness is about 25 GPa or more.

166. (Original) The method of claim 144 wherein said final hardness is about 15 GPa or more.

167. (Original) The method of claim 144 wherein said final hardness is about 20 GPa or more.

B1



168. (Original) The method of claim 144 wherein said final hardness is about 25 GPa  
or more.

169. (Withdrawn)

170. (Withdrawn)

171. (Withdrawn)

172. (Withdrawn)

173. (Withdrawn)

174. (Withdrawn)

175. (Canceled)

176. (Canceled)

177. (Canceled)

178. (Canceled)

179. (Canceled)

180. (Canceled)

181. (Canceled)

182. (Canceled)

183. (Canceled)

184. (Canceled)

185. (Canceled)

186. (Canceled)

187. (Canceled)

188. (Canceled)

189. (Canceled)

B1

- 190. (Canceled)
- 191. (Canceled)
- 192. (Canceled)
- 193. (Canceled)
- 194. (Canceled)
- 195. (Canceled)
- 196. (Canceled)
- 197. (Canceled)
- 198. (Canceled)
- 199. (Canceled)
- 200. (Canceled)
- 201. (Canceled)
- 202. (Canceled)
- 203. (Canceled)
- 204. (Canceled)
- 205. (Canceled)
- 206. (Canceled)
- 207. (Withdrawn)
- 208. (Withdrawn)
- 209. (Withdrawn)
- 210. (Withdrawn)
- 211. (Canceled)

37

212. (Currently amended) A method of forming a lubricious chromium coating comprising:

providing a substrate selected from the group consisting of a chromium coating and a chromium alloy, said substrate comprising a surface comprising substrate chromium atoms, said surface having an initial hardness and an initial coefficient of friction in an unlubricated condition against a steel counterface;  
means for reducing said initial coefficient of friction and for increasing said initial hardness

~~The method of claim 174 wherein said chromium coating comprises an initial hardness, and said means for reducing said initial coefficient of friction further comprises means for increasing said initial hardness.~~

213. (Withdrawn)

214. (Withdrawn)

215. (Withdrawn)

216. (Withdrawn)

217. (Previously added) A method of forming a hard chromium coating comprising:  
providing a chromium coating having an initial hardness; and  
means for increasing said initial hardness.

218. (Canceled)

219. (Withdrawn)

220. (Withdrawn)

221. (Withdrawn)

222. (Withdrawn)

B1

223. (Withdrawn)

224. (Withdrawn)

225. (Withdrawn)

226. (Withdrawn)

227. (Withdrawn)

228. (Withdrawn)

229. (Withdrawn)

230. (Withdrawn)

231. (Withdrawn)

232. (Withdrawn)

233. (Withdrawn)

234. (Withdrawn)

235. (Withdrawn)

236. (Withdrawn)

237. (Withdrawn)

238. (Withdrawn)

239. (New) A method of forming a lubricious outer surface comprising chromium, said method comprising:

providing a substrate selected from the group consisting of a chromium coating and a chromium alloy, said substrate comprising a surface comprising substrate chromium atoms, said surface having an initial coefficient of friction in an unlubricated condition against a steel counterface; and

B1

treating said substrate with an additive comprising an element X under conditions effective to react X with said substrate chromium atoms, producing a mixture adjacent to said lubricious outer surface, said mixture comprising molecules of said substrate and chromium-X molecules comprising said substrate chromium atoms, wherein said lubricious outer surface comprises a sufficient quantity of said chromium-X molecules to produce a final coefficient of friction in an unlubricated condition against a steel counterface that is less than said initial coefficient of friction of said surface,

said additive being selected from the group consisting of

substituted or unsubstituted metal carbonyls comprising a metal selected from the group consisting of tungsten, molybdenum, chromium, iron, and nickel, wherein said substituted carbonyls comprise an oxygen of the carbonyl substituted by an element selected from the group consisting of X; and compounds having the general formula



wherein

n is from about 0 to about 6;

m is from about 1 to about 2;

o is from about 1 to about 2; and,

X is selected from the group consisting of fluorine, oxygen, sulfur, and chlorine.

240. (New) A method of forming a lubricious outer surface comprising chromium, said method comprising:

B1

providing a substrate selected from the group consisting of a chromium coating and a chromium alloy, said substrate comprising a surface comprising substrate chromium atoms, said surface having an initial coefficient of friction in an unlubricated condition against a steel counterface;

treating said surface with an additive comprising oxygen under conditions effective to produce a mixture adjacent to said lubricious outer surface, said mixture comprising substrate molecules and chromium-oxide molecules comprising said substrate chromium atoms, said lubricious outer surface consisting essentially of chromium oxide molecules comprising said substrate chromium atoms;

wherein said lubricous outer surface has a final coefficient of friction in an unlubricated condition against a steel counterface that is less than said initial coefficient of friction.

241. (New) A method of forming a hard surface comprising chromium, said method comprising:

providing a substrate selected from the group consisting of a chromium coating and a chromium alloy comprising substrate chromium atoms, said substrate comprising a surface having an initial hardness;

treating said surface with an additive comprising an element selected from the group consisting of oxygen, carbon, and a combination thereof under conditions effective to produce a final surface having a final hardness greater than said initial hardness, said final surface comprising a mixture adjacent to an outer surface, said mixture comprising substrate molecules and molecules selected from the group

31

consisting of chromium oxide, chromium carbide, and a combination thereof,  
wherein said chromium consists essentially of said substrate chromium atoms.

242. (New) A method for making a medical implant comprising:

providing a component of a medical implant comprising a substrate comprising a  
surface comprising substrate chromium atoms, said surface having an  
initial coefficient of friction in an unlubricated condition against a steel  
counterface;

treating said surface with an additive comprising oxygen under conditions  
effective to produce a mixture adjacent to a lubricious outer surface  
comprising substrate molecules and chromium-oxide molecules consisting  
essentially of said substrate chromium atoms, said surface having a final  
coefficient of friction in an unlubricated condition against a steel  
counterface that is less than said initial coefficient of friction.

243. (New) A method of forming a chromium alloy comprising a lubricious outer  
surface, said method comprising:

providing a chromium alloy substrate, said substrate comprising a surface  
comprising substrate chromium atoms, said surface having an initial  
hardness and an initial coefficient of friction in an unlubricated condition  
against a steel counterface;

means for reducing said initial coefficient of friction and for increasing said initial  
hardness.